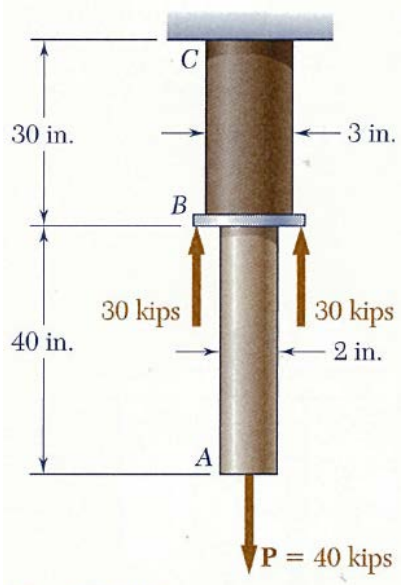
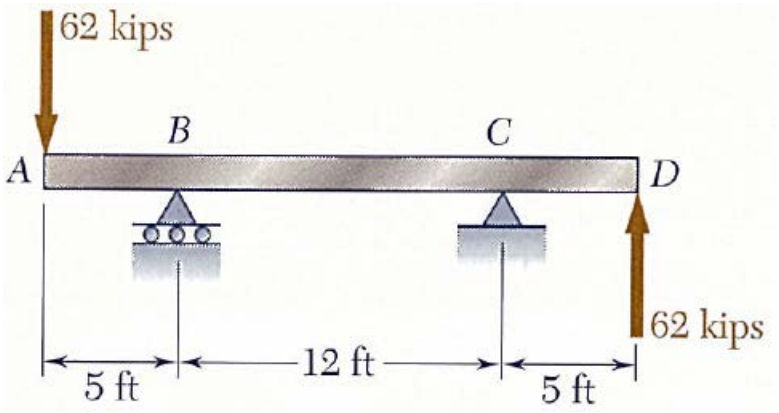
1. The rigid bar EFG is supported by the truss system shown. Knowing that the member CG is a solid circular rod of 0.75-in diameter, determine the normal stress in member CG.

2. A 16 foot long steel rod with a 2-inch diameter is subject to an axial load of 5.7 kips. The modulus of elasticity for titanium: $E = 29 \times 10^6$ psi. Determine (a) the stress in the rod, (b) the longitudinal strain, and (c) the change in length (in inches).

3. Two solid cylindrical rods are joined at B and loaded as shown in the figure below. Rod AB is made of steel (E = 29 x 10^6 psi), and rod BC is made of high strength aluminum (E = 11 x 10^6 psi). Determine (a) the total deformation of the composite rod ABC (up or down?), and (b) the deflection of point B (up or down?).



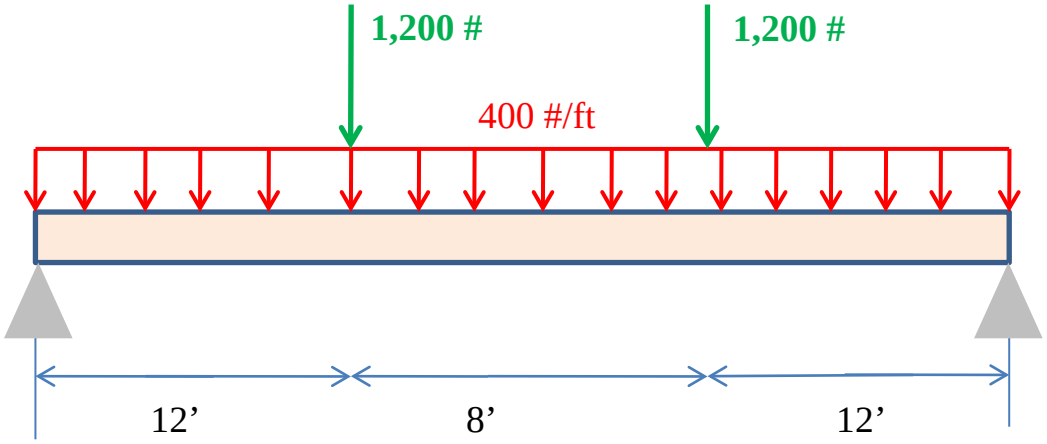
4. For the beam shown below: (a) Draw the shear and moment diagrams. (b) Knowing the allowable stress for the steel used is 24 ksi, select the most economical wide-flange beam to support the loading shown.



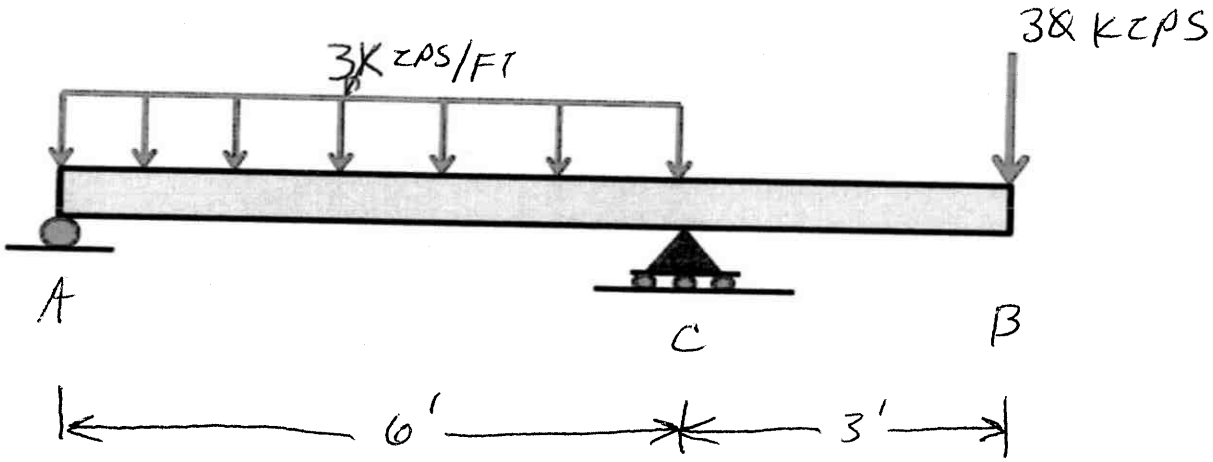
5. A basketball has an outside diameter of 9.55-inches and is subject to 22 psi gage pressure. What is the wall thickness if the normal stress is 475psi?

6. If the given state of stress is (σ_x = 4 ksi, σ_y = -12 ksi, and τ_{xy} = -15 ksi) Determine the maximum stress and the maximum shearing stress (HINT: Use Mohr's Circle)

Draw the shear and moment diagram for the beam and loading shown.
What is the maximum absolute shear and maximum absolute moment?



Draw the shear and moment diagram for the beam and loading shown below.
What is the maximum normal stress, if the section modulus, S = 47.3 in^3?

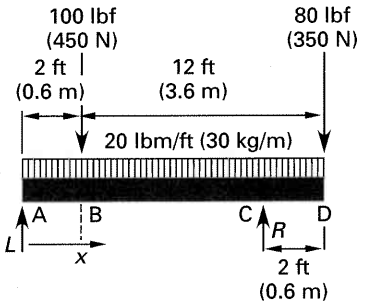


49 Strength of Materials

PRACTICE PROBLEMS

Shear and Moment Diagrams

1. A beam 14 ft (4.2 m) long is supported at the left end and 2 ft (0.6 m) from the right end. The beam has a mass of 20 lbm/ft (30 kg/m). A 100 lbf (450 N) load is applied 2 ft (0.6 m) from the left end. An 80 lbf (350 N) load is applied at the right end.



(a) What is the maximum moment?

(A) 150 ft-lbf (200 N·m)
(B) 250 ft-lbf (340 N·m)
(C) 390 ft-lbf (520 N·m)
(D) 830 ft-lbf (1100 N·m)

(b) What is the maximum shear?

(A) 80 lbf (360 N)
(B) 120 lbf (530 N)
(C) 150 lbf (650 N)
(D) 190 lbf (830 N)

Beam Deflections

2. A cantilever beam is 6 ft (1.8 m) in length. The cross section is 6 in wide by 4 in high (150 mm wide by 100 mm high). The modulus of elasticity is 1.5×10^6 psi (10 GPa). The beam is loaded by two concentrated forces: 200 lbf (900 N) located 1 ft (0.3 m) from the free end and 120 lbf (530 N) located 2 ft (0.6 m) from the free end. What is the tip deflection?

(A) 0.29 in (0.0084 m)
(B) 0.31 in (0.0090 m)
(C) 0.47 in (0.014 m)
(D) 0.55 in (0.015 m)

Thermal Deformation

3. A straight steel beam 200 ft (60 m) long is installed when the temperature is 40°F (4°C). It is supported in such a manner as to allow only 0.5 in (12 mm) longitudinal expansion. Lateral support is provided to prevent buckling. If the temperature increases to 110°F (43°C), what will be the compressive stress in the member?

(A) 3900 lbf/in^2 (28 MPa)
(B) 7400 lbf/in^2 (51 MPa)
(C) 9200 lbf/in^2 (67 MPa)
(D) 12,000 lbf/in^2 (88 MPa)

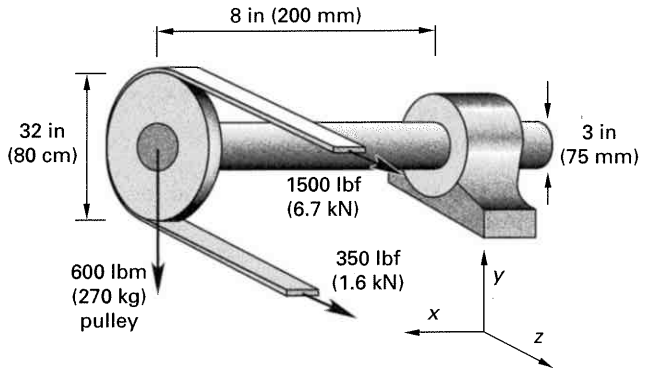
Elastic Deformation

4. A 1 in (25 mm) diameter soft steel rod carries a tensile load of 15,000 lbf (67 kN). The elongation is 0.158 in (4 mm). The modulus of elasticity is 2.9×10^7 lbf/in^2 (200 GPa). What is the total length of the rod?

(A) 239.46 in (5.853 m)
(B) 239.93 in (5.857 m)
(C) 240.03 in (5.861 m)
(D) 240.07 in (5.865 m)

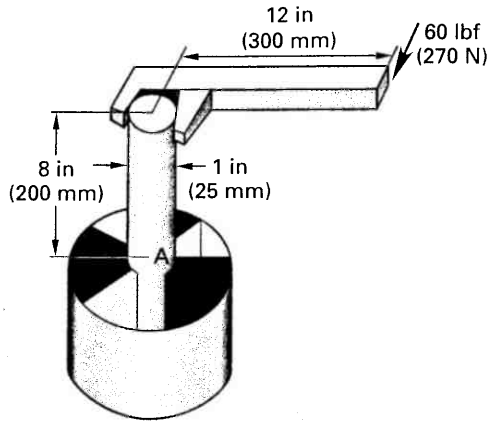
Combined Stresses

5. A 3 in (75 mm) diameter horizontal shaft carries a 32 in (80 cm) diameter, 600 lbm (270 kg) pulley on an overhung (cantilever) end. The pulley is 8 in (200 mm) from the face of the outboard bearing. The pulley belt approaches and leaves horizontally. The belt carries upper and lower tensions of 1500 lbf (6.7 kN) and 350 lbf (1.6 kN), respectively. What is the maximum stress in the shaft?



(A) 4500 lbf/in^2 (32 MPa)
(B) 5500 lbf/in^2 (39 MPa)
(C) 6500 lbf/in^2 (46 MPa)
(D) 7500 lbf/in^2 (54 MPa)

6. A 1.0 in (25 mm) diameter solid rod is held firmly in a chuck. A wrench with a 12 in (300 mm) moment arm applies 60 lbf (270 N) of force 8 in (200 mm) up from the chuck.



(a) What is the maximum shear stress in the rod?
(A) 2900 lbf/in^2 (20 MPa)
(B) 3700 lbf/in^2 (26 MPa)
(C) 4400 lbf/in^2 (32 MPa)
(D) 6800 lbf/in^2 (48 MPa)

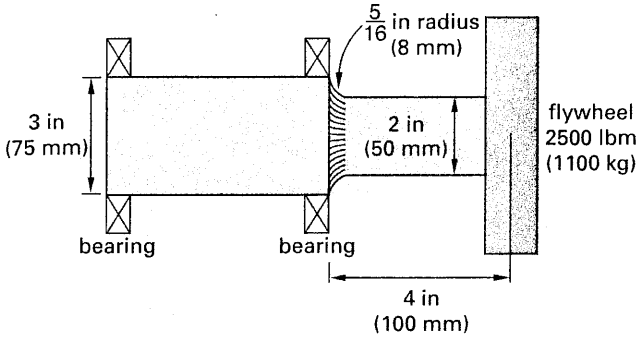
(b) What is the maximum normal stress in the rod?
(A) 5400 lbf/in^2 (38 MPa)
(B) 6900 lbf/in^2 (49 MPa)
(C) 7500 lbf/in^2 (54 MPa)
(D) 11,000 lbf/in^2 (77 MPa)

7. A horizontal square bar with a cross-sectional area of 1.5 in^2 (9.7 cm^2) is acted upon by an 18,000 lbf (80 kN) compressive load at each end. The shear stress in the horizontal direction at a particular point is 4000 lbf/in^2 (28 MPa).

(a) What is the normal stress on a plane inclined +30° from the horizontal?
(A) 460 lbf/in^2 (3.6 MPa)
(B) 930 lbf/in^2 (6.5 MPa)
(C) 1700 lbf/in^2 (12 MPa)
(D) 2400 lbf/in^2 (17 MPa)

(b) What is the shear stress on a plane inclined +30° from the horizontal?
(A) 1700 lbf/in^2 (12 MPa)
(B) 2800 lbf/in^2 (20 MPa)
(C) 3200 lbf/in^2 (22 MPa)
(D) 4100 lbf/in^2 (29 MPa)

10. A 2500 lbm (1100 kg) stationary flywheel is mounted with a 4 in (100 mm) overhang on a stepped shaft as shown. The step fillet has a 5/16 in (8 mm) radius. Disregarding yielding in the vicinity of the fillet, what is the maximum bending stress in the overhanging section of the shaft?



(A) 11,000 lbf/in^2 (77 MPa)
(B) 13,000 lbf/in^2 (91 MPa)
(C) 16,000 lbf/in^2 (110 MPa)
(D) 19,000 lbf/in^2 (130 MPa)

Composite Structures

11. A bimetallic spring is constructed of an aluminum strip with a 1/8 in by 1 1/2 in (3.2 mm by 38 mm) cross section bonded on top of a 1/16 in by 1 1/2 in (1.6 mm by 38 mm) steel strip. The modulus of elasticity of the aluminum is 10×10^6 lbf/in^2 (70 GPa). The modulus of elasticity of the steel is 30×10^6 lbf/in^2 (200 GPa). What is the equivalent, all-aluminum centroidal area moment of inertia of the cross section?
(A) 2.4×10^{-4} in^4 (190 mm^4)
(B) 5.2×10^{-4} in^4 (390 mm^4)
(C) 1.3×10^{-3} in^4 (550 mm^4)
(D) 2.6×10^{-3} in^4 (1100 mm^4)